Method of visualizing the perfusion of an organ while utilizing a perfusion measurement

The invention relates to a method of visualizing the perfusion of an organ, notably the myocardium of a patient, while utilizing a perfusion measurement, in which method a series of images of the organ that has been acquired by way of the perfusion measurement is displayed on a display device so as to be visually inspected.

A method of this kind is known from practice and is based on the use of, for example the MR perfusion measuring technique. In order to obtain reliable images, it is desirable that the patient undergoing the examination is immobilized as well as possible on an examination table and moves as little as possible during the actual perfusion measurement. The perfusion measurement itself is initiated by injection of a contrast liquid that facilitates the perfusion measurement and enables the reproduction of images wherefrom the perfusion of the organ can be deduced.

A problem encountered during such a known perfusion measurement is that the patient moves during the measurement or cannot hold his or her breath, so that the position of the organ being measured changes. The analysis of the perfusion behavior of the organ examined is thus impeded, because in that case the intensity variation of the injected contrast liquid in successive images cannot be compared very well.

It is an object of the invention to solve this problem; to this end, according to the invention it is proposed to perform a transformation operation on every pair of successive images from the series of images of the organ in such a manner that, subsequent to the transformation, the organ will be displayed essentially in a fixed position after completion of the transformation operation.

A first version of the method in accordance with the invention that can be implemented very well is characterized in that the first image in time serves as a reference base and that each of the subsequent images is transformed so as to minimize differences between each of these images and the reference base.

An alternative version that is to be preferred, however, is characterized in that the first image in time of every pair of successive images serves as a reference base and that the subsequent second image is transformed so as to minimize differences between said second image and the reference base. This version yields a stable image in which

comparatively small variations that occur during a practical perfusion measurement can be suitably tracked, so that the series of images presented for visual inspection enables very adequate analysis of the perfusion behavior of the organ being examined.

It is desirable that the transformation operation is composed of a rotation operation and a translation operation that are performed on the image so as to avoid that complex compression operations or other operations are performed on the image of the organ being examined.

In conformity with a further aspect of the invention the method is characterized in that prior to the transformation operation there is determined a reference region in the image that constitutes the reference base and in the subsequent image, and that the transformation operation is determined by minimizing the differences in the reference region of successive images. The perfusion behavior of the organ being examined can thus be suitably visualized while other, less important parts of the image are subject to a displacement, for example due to the patient's respiration. In order to achieve the foregoing, it is particularly desirable that the reference region is bounded by the immediate vicinity of the organ being examined.

It is an important further aspect of the invention that the transformation operation as determined by means of the reference region is performed on the entire image. An image that has been subjected to the complete transformation operation can thus advantageously serve as a reference base for a subsequent image, because the transformation operation ensures that no voids arise at the edges of the reference region of the transformed image.

The invention also relates to a data processing system as defined in Claim 8. The data processing system of the invention is arranged to carry out the method of the invention.

The invention also relates to a computer program as claimed in Claim 9. The computer program according to the invention can be loaded into the working memory of a data processing system, so that the data processing system can carry out the method of the invention.

Preferably, the computer program of the invention may be made available from a data carrier, such as a CD rom disk. The computer program may also be downloaded from a data network such as the 'world-wide wel'.

The invention will be described in detail hereinafter on the basis of a non-limitative example of a preferred version of the method in accordance with the invention and with reference to the drawing with a single diagrammatic Figure.

Each time a pair of successive images is selected from a number of images (which number is known or not) that are arranged in series, for example the image $B_{i-1,r}$ and the subsequent image $B_{i,o}$. The image $B_{i-1,r}$ bears the sequence number i-1 and is formed from an image $B_{i-1,o}$ that concerns the actual exposure of the organ being examined wherefrom the image has been acquired. Transformation of this image $B_{i-1,o}$ in conformity with the method of the invention to be described in detail hereinafter yields the transformed image $B_{i-1,r}$. A reference region ROI_{i-1} is defined in the image $B_{i-1,r}$. This operation can be performed manually or automatically. The organ being examined should be situated completely within the region that is indicated by the reference ROI_{i-1}; the boundary of the reference region ROI_{i-1} that is denoted by the dashed line marks the immediate vicinity of the organ being examined.

An image $B_{i,r}$ that succeeds the image $B_{i-1,r}$ and bears the sequence number i is then determined as follows. This operation is based on an image $B_{i,o}$ that succeeds a previous image $B_{i-1,o}$, after which a reference region ROI_i is defined in said image $B_{i,o}$, which reference region is bounded in the same way as the reference image ROI_{i-1} in the image $B_{i-1,r}$. The two reference regions ROI_{i-1} and ROI_i are subsequently analyzed in an organ 1 in order to determine the degree of rotation and translation of ROI_i relative to ROI_{i-1} that is necessary so as to minimize the differences between ROI_{i-1} and ROI_i. To this end, the organ 1 applies a control signal 2 to a transformation member 3 which performs a rotation and/or translation on the entire image $B_{i,o}$ in order to obtain the image $B_{i,r}$ that can subsequently be presented, after the image $B_{i-1,r}$, on the display device for visual inspection. During a next step of the operation the image $B_{i,r}$ takes the position of the image $B_{i-1,r}$ that is shown in the Figure, so that the execution of the described method can be repeated for the subsequent image $B_{i+1,o}$ in order to form the image $B_{i+1,r}$.